

Report to
Department of the Army
Jacksonville District, Corps of Engineers
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on

**A STUDY OF TIDAL TRANSPORT AND
DIFFUSION IN BEAR CUT, DADE COUNTY, FLORIDA**

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[Restored and transferred to electronic form by A. Cantillo (NOAA) in 1999. Original stored at the Library, Rosenstiel School of Marine and Atmospheric Science, University of Miami. Minor editorial changes were made.]

Purpose of the Study

This study was designed to determine the disposition of suspended solids resulting from the deposition of hydraulic fill along the shore of Virginia Key. This fill was to be used in the proposed beach nourishment program to be undertaken by the U.S. Army Corps of Engineers. Particular attention was to be directed toward the effect on salt water intakes at the U.S. Bureau of Commercial Fisheries Tropical Atlantic Biological Laboratory (TABL), The Institute of Marine Sciences, University of Miami (IMS) and the Miami Seaquarium. It has been indicated that heavy concentrations of suspended material at these intakes might result in the death of many scientifically valuable specimens.

The Study Program

In view of the rather limited time and funding available, it was decided to concentrate the study on the transport in Bear Cut during maximum flood tides as this was judged to be the most critical condition for the intakes.

The study program was divided into three steps to be conducted at least twice so that the effect of tidal variations could be seen.

The first step consisted of measuring the flood tide current at stations along the Bear Cut Bridge as shown on Figure 1. For this purpose a Gurley-Price current meter was used. These measurements were reduced to estimated maximum spring flood values to determine the maximum total transport.

The next step was the release and tracking of dye samples released along the beach on the predicted maximum flood tide. Rhodamine-B 500% concentrate dye was used. It was introduced into the water by placing the crystals in a flexible plastic tube about two feet in diameter. When the time to release the sample arrived, the tube was pulled away allowing the solution to escape in a coherent mass. The location and time of releases is shown on Figure 1. Tracking was accomplished from a helicopter and color photographs were taken of the dye pattern as long as it was possible.

In addition to the visual and photographic tracking, sampling stations were established at the intake of TABL, IMS and the Seaquarium and at 13 locations along the Bear Cut Bridge. Samples taken periodically at these stations during the passage of the dye were analyzed in the laboratory by utilizing a Turner Model II fluorometer.

The field work

An analysis of past current measurements made by the Institute of Marine Sciences, Division of Physical Oceanography revealed a close agreement between the times of slack water in Bear Cut and that predicted by the U.S. Coast and Geodetic Survey for Government Cut. Therefore, release times for samples were selected from predicted values at Government Cut. All the samples were released in about 3 feet of water approximately 100 feet from shore to simulate the placing of hydraulic fill.

After several postponements due to adverse weather conditions, the first test was run on 5 March 1968. The release of one point of dye concentrate was made at 1024 hours at the location shown in Figure 1. [THERE WAS NO FIGURE 1 IN COPY STORED AT THE UNIVERSITY OF MIAMI.] The pattern was tracked and samples taken. By 1104 hours the sample was due south of the Seaquarium boat basin and over a dark bottom so that further tracking was impossible.

On 22 March sample No. 1 was released at 1309 hours on the basis of a predicted maximum flood current at Government Cut at 1400 hours. Visual tracking soon showed that the sample moved very slowly and would never reach the sampling stations. Consequently at 1438 another sample, sample No. 2, was released closer to the stations in hope it would reach them. Tracking of both samples continued until 1525 by which time they had reversed direction and were headed out to sea. This severe conflict with the prediction caused considerable concern and an explanation was sought.

An examination of U.S. Weather Bureau reports for Miami Beach revealed that winds of between 15 and 20 knots from the southeast and south-southeast had blown all day. Set-up in Biscayne Bay as a result of these winds probably caused the early reversal of the current.

Since the second test yielded no useful results, another one was staged on 5 April. Two samples using one pound each of the concentrate were released as shown on Figure 1. Sample No. 1 was released at 1130 hours which was exactly the predicted time of maximum flood at Government Cut. Sample No. 2 was released 2200 feet to the east at 1143. These samples moved normally, but more slowly than expected. Again, this can be explained by southerly winds of between 12 and 15 knots. In spite of this, results appeared to be acceptable.

Current measurements were originally made on 17 April and verified on the 30th.

Results of the Tests

The measurements of current velocity showed that the maximum flood tide velocities occurred approximately 1000 feet from the westerly end of the bridge. The maximum velocity when adjusted for spring tide conditions will be approximately 4 feet per second. The velocity decreases as shore on either side of this station is approached reaching a value of 1.8 feet per second at a station 100 feet from the westerly end of the bridge.

Turbulent diffusion in the inlet at the times studied was relatively slight and the dye patterns remained concentrated along the shore. Maximum concentration of 90 parts per billion (ppb) were received by TABL and IMS on 5 March. The Seaquarium received no dye on 5 March, but a maximum of 80 ppb on 5 April as compared to 50 ppb for IMS. on that date. This apparent discrepancy can be explained by the fact that the wind was southerly on 5 April and northerly on 5 March. On the bridge only Station 1+00 received detectable concentrations which indicates that virtually all of the dye was concentrated in the westerly 300 feet of the channel.

Conclusion

On the basis of the studies done, the following conclusions are reached:

1. Hydraulic placement of random beach fill on Virginia Key can result in concentrations of suspended material at the intakes of TABL, IMS and the Seaquarium.
2. Heavy concentrations of this material will be limited to the westerly 300 feet of the channel.
3. The circulation in Bear Cut is greatly influenced by the intensity and direction of the wind.

Since this study involved only two successful tests, conclusions 1 and 2 above should be accepted with some caution in view of conclusion 3 which is extremely

Subsequent Action by the Corps of Engineers

"General and Detail Design Memorandum, Virginia Key and Key Biscayne, Florida, Beach Erosion Control" Jacksonville District, Corps of Engineers dated February 1968 indicates that certain definite measures will be taken to alleviate the problem of suspended sediment at the intakes. These measures include:

1. Elimination of borrow areas off Virginia Key.
2. Supply of fill to Virginia Key by trucking after it has been stockpiled by hydraulic methods on Key Biscayne.
3. Extension of the TABL. and IMS. intakes to 300 feet from shore.

Recommendation

These measures will greatly alleviate any problems of silting. It is, however, recommended that careful surveillance be maintained over the Seaquarium intake to assure that excess sediment does not enter it. Critical conditions are expected to occur during strong southerly winds.

Acknowledgement

The contribution of members of the staff of TABL and the Seaquarium in providing information and assisting in the field work was greatly appreciated as is that of graduate students in the Institute of Marine Sciences ocean engineering program.